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SOME STAGES IN THE DEVELOPMENT OF PELLIA EPIPHYLLA.

(CONCLUDED)

HELEN E. GREENWOOD.

After this time collections were made Aug. 17, 18, 21 and 23, on the latter date two being made from widely separated localities. The most advanced stage of this group came from the collection of Aug. 18 (fig. 38). Here the differentiation into spore mother cells and elater forming cells has proceeded still further. These cells seem to be surrounded by a reticulated protoplasm, the network showing more or less distinctly with a fairly low power. The only difference noted in that collected on the twenty-third was that there were more loose cells in the open space within the capsule and the difference between the two kinds of cells was still more evident.

On August 28, growth was found to have gone on so rapidly that with a low power magnifier the sporogonium seemed to be fully developed into a stem and well rounded out capsule. Vertical sections (fig. 39) through this material show that the archesporial division has been completed, the spore mother cells with their large nuclei are separated from each other and from the much elongated young elaters with their correspondingly small nuclei. The difference between the stem and the foot is now well defined, the latter forming a pointed cap which overlaps the base of the seta. The spore mother cells are in general spherical but a few of the more advanced ones show a tendency to become lobed.

Vertical sections through sporogonia collected September 3 show a decided development in the spore mother cells over those collected Aug. 28 (fig. 40). They have all become distinctly lobed (fig. 41) but are still much scattered, occupying comparatively little space within the capsule. The elaters on the other hand, have much the same appearance, still being distinctly nucleate with no signs of spiral thickenings on the wall.

Sections through capsules collected on Sept. 16 show the lobed spore mother cells to be much crowded and these now occupy a proportionately large space in comparison to the elaters which are still nucleate.

Material collected Sept. 25 and Oct. 18 presents very similar stages of development (fig. 43). In both, the spore mother cells have become conspicuously four-lobed, but these four lobes diverge

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from one another in such a way that in a thin section we seldom see the four divisions in one plane and so they appear instead to be three lobed. In the former, the spiral thickenings in the walls of the elaters are very faint but in the latter these are plainly marked and the contrast in size between the fixed and free elaters is evident, the former being much larger.

Before passing on to the later stages, attention should be called to the flattened cells arranged in longitudinal rows in the stems of the sporogonia (figs. 39, 40, 41, 43, 44) so characteristic of *Pellia epiphylla*.

No further collecting was done until Nov. 21. The weather had been sufficiently mild to melt the two light snows that had fallen earlier in the month and the plants did not seem to be at all frozen. The involucres fitted so tightly over the little cavities in which the capsules lay that it was difficult to tell at the first glance whether there was a capsule enclosed or not. The capsules were very variable in size and on the whole seemed smaller than those collected in the latter part of September and October. No four-lobed spore mother cells were to be found now, but in their places were the fully formed oval spores (fig. 44). Evidently the formation of the spores from the four-lobed spore mother cells occurs in the latter part of October or the first part of November.[1]

Sections through capsules collected Nov. 27 showed that not only have the spores been formed but that cell division has already begun to divide each of them into a multicellular body, i.e. the first stages in germination have already taken place (figs. 45 and 46a, b, c,) some of the spores are two celled, others four celled (46a), while others have each of the central cells divided again (46b). The walls of the spores seem to be very thin.

On the next collecting date, Dec. 29, the ground was covered with quite a thick coating of snow, so *Pellia epiphylla* could only be found in a few bare spots and then the ground was frozen so that the plants had to be scraped off with a knife Each thallus was almost black and thin, dry and papery. The capsules were so shrunken down and hidden under the tightly closed involucres that it was necessary to look carefully to find them. The plants lay in a closed tin box over night in a fairly warm room and so lost their papery character, becoming rubbery instead. The next morning the capsules still seemed much shrunken but as soon as they were placed in the fixing solution, they expanded to their natural size. Vertical sections

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1. This process of cell division has been described by Dr. Davis, as follows: (Nuclear studies in Pellia, B. M. Davis, Ann. of Bot. **15**:247).

"The cell wall laid down after the first mitosis separates the lobes of the spore mother cell into pairs which lie at an angle to one another, if not perpendicular * * * a cell plate appears in the equatorial region of the spindle and is then shortly replaced by a cell wall and the division of the spore mother cells is complete."

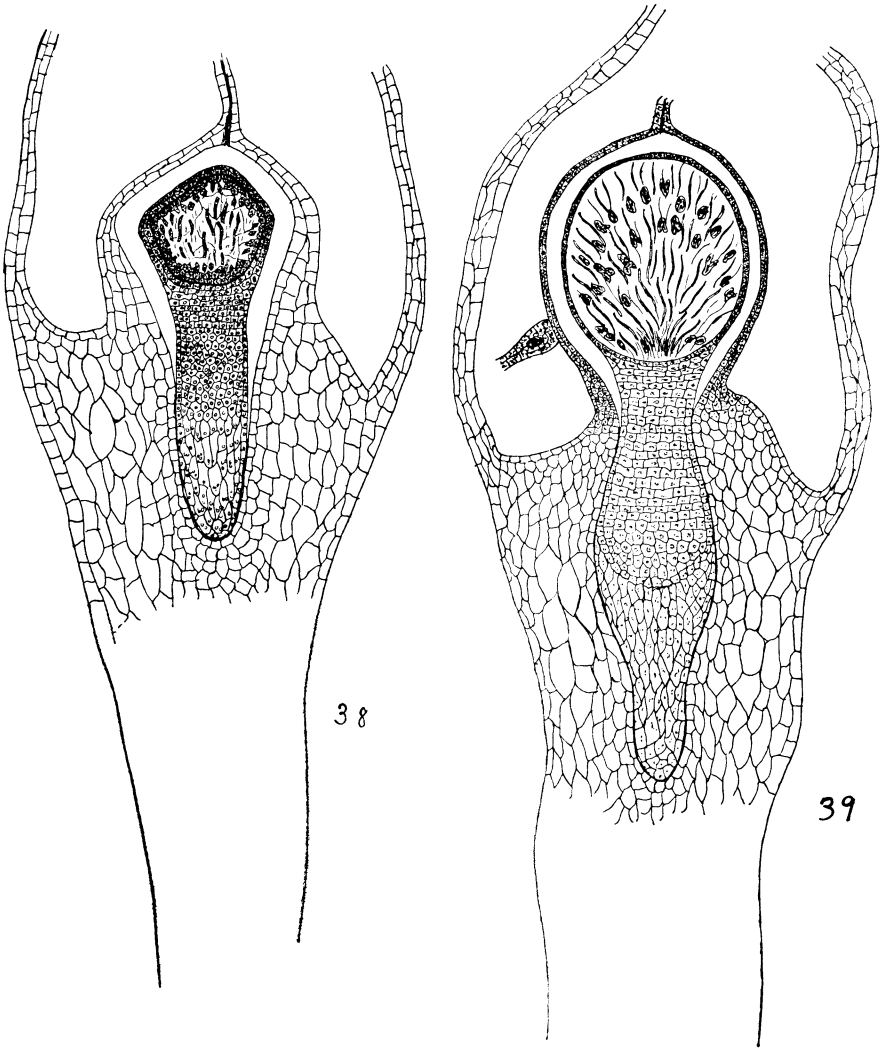

PLATE XIII

Fig. 38. Median longitudinal section through young sporogonium × 75. Aug. 18 Seta and foot have elongated and greater differentiation is seen between the two kinds of cells both in this region and in the capsule.

Fig. 39. Median longitudinal section through young sporogonium × 75. Aug. 28. Withered neck of archegonium still persists and an old undeveloped archegonium has been carried up on side of calyptra. Spore mother cells slightly lobed, nucleate elaters.

(fig. 49) showed the capsule wall to be generally two layers in thickness, the central space to be filled with the bunch of fixed elaters (which grow up from the base of the capsule), and the spores surrounded by free elaters scattered through the capsule cavity.

Weather conditions prevented any collection being made in January, but Feb. 7 found the temperature high enough, and the woods open enough for a collecting trip. The ground was quite thoroughly covered with a layer of ice and snow, but on just one tussock over the water's edge the snow had melted and the plants of *Pellia epiphylla* had softened up so that they could be easily gathered. Some of the capsules were very large and nearly pushed out from under the involucres, looking as if sufficiently encouraged by warm weather they would shed their spores very soon. Vertical sections through these capsules show the spore cavity to be much crowded with spores, the elaters being pressed into a small space (fig. 50).

The next collection was made on March 13. No change had taken place in the contents of the capsule (fig. 51). Vertical sections through the spores show almost exactly the same condition as those collected Nov. 27. The same figures (46a, b, & c,) represent these exactly. Evidently the spores are fully formed in November, and the intrasporal development so characteristic of *Pellia epiphylla* is completed by the last of November. Therefore the spores must remain in a dormant condition over winter from November until they are shed in the following April.

On April 24, the few capsules not already opened were collected. They were so sensitive to heat that as soon as they were placed in the paraffine oven and the temperature began to rise toward the melting point, the four valves split open from apex to base curving tightly back against the seta and the spores were scattered through the fluid. The sections, therefore, were very fragmentary, being composed mainly of the capsule with the tuft of fixed elaters fastened securely to it and varying amounts of spores and free elaters scattered about over the sections. None of the spores were sectioned through, only outside views being presented. The spores are oval in shape, the outer wall being marked by irregular ridges or thickenings.

This brings us back to the last of April, the point where we started, and completes the year's record of the stages of the development of *Pellia epiphylla.*

SUMMARY.

1. *Pellia epiphylla* grows in shaded locations on damp soil in swamps and bogs, on moist roadsides, or on the banks of streams.

2. The plant body is a slightly fleshy thallus, oblong, more or less sinuate, lobed or forked, the shape being modified according to the way it is crowded by other plants, an average size being from about a half an inch in width to an inch or an inch and a half in length.

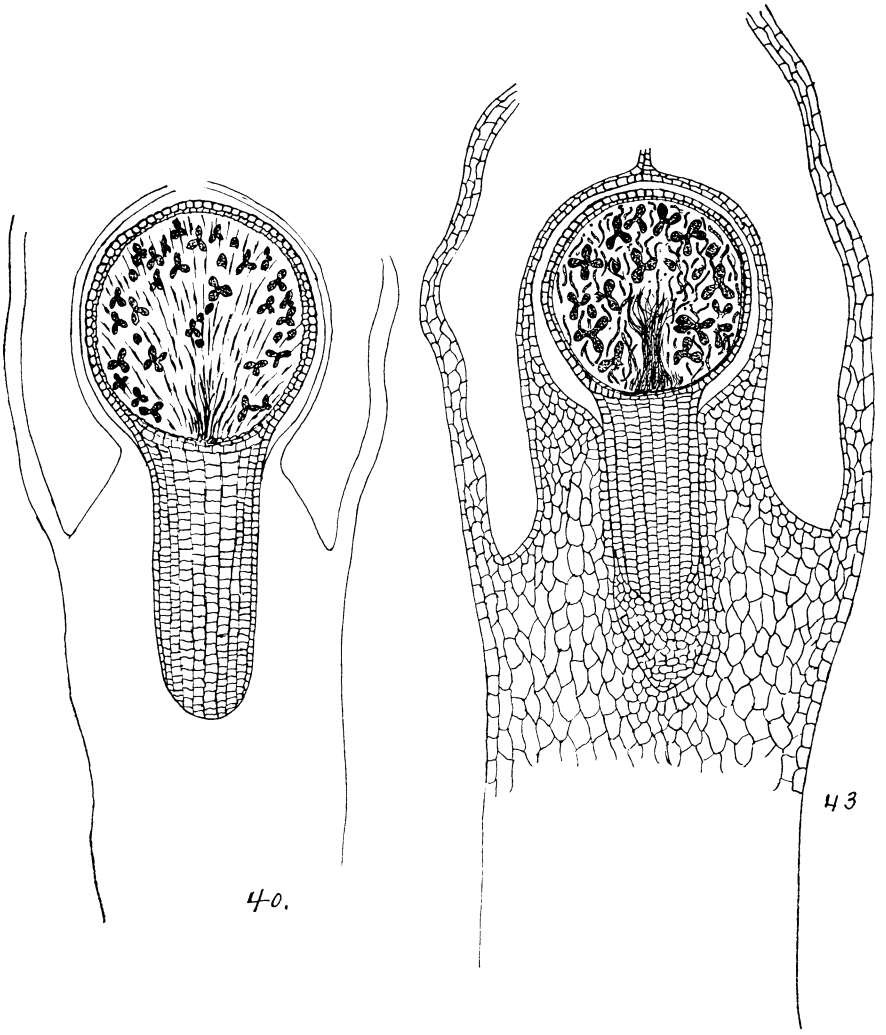

PLATE XIV

Fig. 40. Median longitudinal section of sporogonium × 82. Sept. 3. Spore mother cells all lobed, nucleate elaters.

Fig. 43. Median longitudinal section through sporogonium. Oct. 18. × 82. Elaters now show spiral thickenings.
(Fig. 42 of Miss Greenwood is omitted).

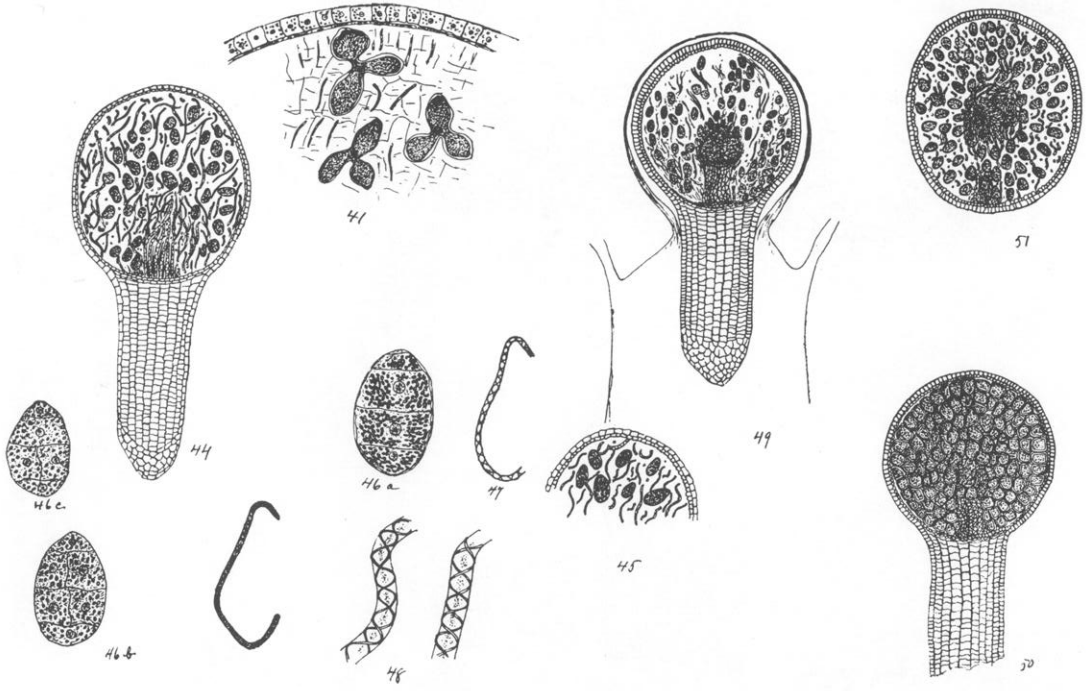

PLATE XV

3. The thallus is composed of parenchyma cells bordered by an epidermal row of cells above and below, being abundantly provided with rhizoids.

4. *Pellia epiphylla* is monoecious, the antheridia being scattered along the middle of the thallus to the tip, while the archegonia are formed just behind the growing point.

5. In this locality the spores are shed in the latter half of April.

6. The old plants then die down and new shoots immediately spring out from the edges of these plants.

7. Antheridia soon make their appearance on these new shoots. The early stages of antheridia should be looked for shortly after the middle of April.

8. The mature stages of the antheridia may be found from the last of April through May and June.

9. Archegonia may be found early in June.

10. According to observations on material collected in 1909 and 1910 fertilization does not take place until early July. As both these seasons were unusually dry, fertilization may normally occur in June, if the rainfall is heavier.

11. After fertilization the embryo grows rapidly through July and develops into a pear-shaped body.

EXPLANATION OF PLATE XV

Fig. 41. Vertical section through small portion of capsule represented in fig. 40, × 233. Capsule wall two layered. Lobed spore mother cells with nucleus near center, elaters still in nucleate stage.

Fig. 44. Median longitudinal section through sporogonium. Coll. Nov. 21. × 55.

Fig. 45. Portion of vertical section through capsule. Coll. Nov. 27. × 55.

Fig. 46 a, b, c. Vertical sections through spores from capsules. Coll. Nov. 27. × 330. Spores have already begun to divide into a multicellular body, i. e., the development of the gametophyte has already begun. Vertical sections through spores collected Mar. 13, have the same appearance.

Fig. 47. Single elater × 55.

Fig. 48. Portions of elaters × 330.

Fig. 49. Median longitudinal section through sporogonium. Coll. Dec. 29. × 55.

Fig. 50. Median longitudinal section through sporogonium. Coll. Feb. 7. × 55.

Fig. 51. Median longitudinal section through capsule. Coll. Mar. 13. × 55.

12. The cells of the venter undergo many divisions and develop a protective covering called the calyptra.

13. By the middle of August a differentiation of cells is seen in the larger end of the young embryo. The inner ones are the archesporial cells and the outer ones will form the capsule wall.

14. The calyptra which has kept pace with the growth of the embryo now ceases development.

15. About August 15, the cells in the archesporial region differentiate into spore mother cells and elater-forming cells.

16. The three regions of the sporogonium (capsule, seta, foot) begin to be evident.

17. Development goes on with great rapidity until by the last of August the slightly lobed spore mother cells and nucleate elaters are to be seen occupying the space within the capsule.

18. The sporogonium is now (Aug. 28) fully formed with its globular capsule, short seta, and pointed, conical foot.

19. The wall of the capsule consists generally of two layers of cells, except in the region of the base where there are usually one or two more layers.

20. Early in September the spore mother cells all become lobed.

21. Throughout September and October the spore mother cells remain in the lobed condition and not until October do the spiral thickenings appear on the walls of the elaters.

22. By the middle of November the lobed spore mother cells have divided to form the oval spores.

23. By the last of November the first stages of germination have taken place, each spore being divided into a several-celled body.

24. No further change takes place in the spores until they are shed in April.

25. The abundance or lack of moisture has a marked influence on the development of the plants. Those growing in moist situations are more advanced on a given date than those of a drier location.

26. Plants in a very moist habitat are very apt to be sterile.

27. Those most thoroughly fruited are found on drier soil.

ADDITIONS TO THE LICHEN FLORA OF SOUTHERN CALIFORNIA. No. 6.

By H. E. HASSE, M. D.

Heppia Zahlbruckneri spec. nov.

Thallus of short, erect, terete to subterete lobules, 1 to 2 mm thick and 3 to 3.5 mm high, aggregated into groups and loosely attached to the substrate by medullary hyphae; the apices are clavate to bulbous, often spreading and assuming a flattened top; the color is olive-green and darkening. The pseudoparenchymatous cortex, containing the gonidial layer, is 40 μ thick, the pale green *Scytonema* gonidia are